

POWER SEMICONDUCTOR MODULE WITH CERAMIC SUBSTRATE

5 Cross-Reference to Related Application:

This is a continuation of copending International Application PCT/DE98/01266, filed May 7, 1998, which designated the United States.

10 Background of the Invention:

Field of the Invention:

The invention relates to a power semiconductor module with a plastic housing into which a substrate is inserted as a housing base. The substrate contains a ceramic plate provided with a metallization layer on top and bottom sides. The metallization layer on the top side of the ceramic plate faces an interior of the housing and is patterned in order to form interconnects. The power semiconductor module is equipped with semiconductor components and connecting elements, and in which terminal elements for external terminals are introduced.

Such power semiconductor modules have been known for a long time. In the case of these power semiconductor modules, the terminal elements for the external terminals are disposed in the plastic housing. In this case, the terminal elements, which are composed of copper as a rule, are injection-molded

into the plastic housing. However, plastic has the property of shrinking when it cools, in other words after the injection molding. The result of this is that the terminal elements are not, as a rule, anchored fixedly in the plastic. Wires are bonded onto the terminal elements in the interior of the housing, the other end of which wires is bonded onto the semiconductor components. These wires are composed of aluminum as a rule. By virtue of the fact that the plastic shrinks after the injection molding, however, it can happen that, owing to the poor mechanical fixing of the terminal elements in the plastic housing, the bond present in the interior of the housing may become detached. This leads to the failure of the power semiconductor module.

Summary of the Invention:

It is accordingly an object of the invention to provide a power semiconductor module with a ceramic substrate that overcomes the above-mentioned disadvantages of the prior art devices of this general type, which exhibits very good mechanical fixing of the terminal elements, with the result that the above-mentioned problems do not arise. Furthermore, the object of the present invention is to further simplify the method for producing the plastic housing.

With the foregoing and other objects in view there is

provided, in accordance with the invention, a power semiconductor module, including:

semiconductor components;

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a plastic housing having an interior and connecting element openings formed therein;

10 a substrate disposed in the plastic housing defining a housing base of the plastic housing, the substrate containing a

15 ceramic plate having a top side and a bottom side with a top metallization layer disposed on the top side and a bottom metallization layer disposed on the bottom side, the top metallization layer facing the interior of the plastic housing being patterned in order to form interconnects and equipped for and receiving the semiconductor components;

connecting elements interconnecting the semiconductor components; and

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terminal elements for providing external terminals press-fitted into the connecting element openings in the plastic housing.

This object is achieved according to the invention by virtue of the fact that the terminal elements are press-fitted into openings in the plastic housing.

5 As a result of this measure, the metal parts are fixed into the plastic housing by a relatively simple method. In particular, this method does not need a separate injection mold into which the terminal elements are placed before each injection-molding process and subsequently encapsulated by the
10 injection molding.

Furthermore, as a result of the terminal elements being press-fitted into the openings in the plastic housing, the elements are anchored considerably better therein, thereby enabling
15 reliable bonds in the interior of the housing.

In a development of the present invention, the terminal elements have lugs that bear on an inner side of the plastic housing and fix the terminal elements in their position. The
20 lugs are preferably configured as barbs, with the result that the terminal elements are guided tightly in the openings and secured from withdrawal. It is also conceivable for the terminal elements to be provided with offsets that fix the terminal elements in the openings.

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The terminal elements expediently have regions in the interior of the housing which run approximately parallel to the housing base. This considerably facilitates the bonding process.

- 5 The plastic housing typically contains a frame and a cover, the terminal elements being disposed in the frame.

The substrate is covered, within the housing, with a potting compound that serves to encapsulate the substrate in a
10 moisture-tight manner.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

- 15 Although the invention is illustrated and described herein as embodied in a power semiconductor module with a ceramic substrate, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit
20 of the invention and within the scope and range of equivalents of the claims.

The construction and method of operation of the invention, however, together with additional objects and advantages
25 thereof will be best understood from the following description

of specific embodiments when read in connection with the accompanying drawings.

Brief Description of the Drawings:

5 Fig. 1 is a diagrammatic, cross-sectional view through a power semiconductor module according to the prior art; and

Fig. 2 is an enlarged, partial, sectional view of a frame of a plastic housing according to the invention.

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Description of the Preferred Embodiments:

In all the figures of the drawing, sub-features and integral parts that correspond to one another bear the same reference symbol in each case. Referring now to the figures of the drawing in detail and first, particularly, to Fig. 1 thereof, there is shown a power semiconductor module 1 containing a plastic housing 2, into which a substrate 4 is inserted as a housing base 3.

15 20 The substrate 4 contains a ceramic plate 5 provided with a metallization layer on its top side 6 and on its bottom side 7. The metallization layer on the top side 6 faces the interior of the housing 2 and is patterned to form interconnects. Semiconductor components 10 are applied on the top side 6 of the ceramic plate 5. The semiconductor components 10 are, as a rule, power semiconductor components

such as IGBTs, MCTs, power transistors or power diodes. Furthermore, connecting elements 8 configured as aluminum wires are situated there. The connecting elements 8 are applied on the semiconductor components 10 by bonding methods.

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The plastic housing 2 includes a frame 9 and a cover. Here terminal elements 11 for external terminals are injection-molded into the frame 9 according to the prior art.

10 In this case, the terminal elements 11 are injection-molded into the frame 9, which is composed of plastic, using a separate injection mold. The relevant terminal element is placed into the injection mold before each injection-molding process and is subsequently encapsulated by injection molding.

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Fig. 2 shows a plastic frame according to the present invention, in which the terminal elements 11 are press-fitted into openings 12 in the plastic frame 9. The terminal elements 11 in this case have lugs 13, which bear on an inner side of the plastic housing 2. The terminal elements 11 are thereby fixed in their position. The lugs 13 have the function of barbs that secure the terminal elements 11 against unintentional withdrawal. The bonds between the terminal elements 11 and the semiconductor components 10 and/or connecting elements 8 are thereby secured against destruction.

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The terminal elements 11 run approximately parallel to the housing base 3 in the interior of the housing 2. The plastic housing 2 shown here includes the plastic frame 9 and the cover. The substrate 4 is covered with a potting compound.

- 5 The potting compound is formed of a hard potting compound layer disposed on a soft potting compound layer.